

24th, both preceded by heavy swell and followed by low dew-point. The north wind evidently precipitated the terrific downpour on north Hilo. There was lightning reported from Hawaii for the 8th, 9th, 13th, 24th, and 25th, and Maui on the 8th. Snow fell on Mauna Kea and Mauna Loa on the 8th and 24th; on Haleakala on the 8th or 9th. Earthquake reported at Hilo, 7:30 p. m. on the 2d.

### AN AURORAL-LUNAR HALO DISPLAY.

H. H. TEN BROECK, Braidentown, Fla., dated December 29, 1901.

At midnight of the 28th I observed an auroral display with an axis extending about west-northwest to east-southeast. There was at the time an unusually brilliant halo around the moon, about 45° in diameter. The upper half was fringed on the edge by rays about 3° or 4° long, a few much longer, radiating, not from the moon (the center of the halo), but from a point below it about east-southeast on the horizon. Some of the rays extended northward as far as Cassiopeia while the Pleiades were a little south of the center of the long bands, which converged toward a point about west-northwest on the horizon, although not reaching it by 10° or 15°. The bands and the rays on the halo appeared and disappeared slowly like auroral bands and were of a pale white color. There was an 8 or 10 mile southeasterly wind blowing and half of the sky was covered with very light clouds of a cirro-cumulus order, with an almost imperceptible motion. Very few of the bands extended below the moon. The fringe of rays on the upper edge of the halo was well marked and closely resembled that often seen on an auroral arch; it, too, changed in brightness, slowly, as well as in length. It was a well-marked auroral display, with the moon's halo as a starting point. In half an hour the halo and bands had disappeared as well as most of the clouds.

I have never before seen or heard of an aurora from a lunar halo, nor one with its middle line running west-northwest and east-southeast.

### MEXICAN CLIMATOLOGICAL DATA.

Through the kind cooperation of Señor Manuel E. Pastrana, Director of the Central Meteorologic-Magnetic Observatory, the monthly summaries of Mexican data are now communicated in manuscript, in advance of their publication in the Boletín Mensual. An abstract, translated into English measures, is here given, in continuation of the similar tables published in the MONTHLY WEATHER REVIEW since 1896. The barometric means are now reduced to standard gravity.

*Mexican data for December, 1901.*

Stations.	Altitude.	Mean barometer.	Temperature.			Relative humidity.	Precipitation.	Prevailing direction.	
			Max.	Min.	Mean.			Wind.	Cloud.
Chihuahua.....	Feet.	Inch.	° F.	° F.	° F.	%	Inch.		
Guadalajara.....	4,069	25.33	80.6	23.0	53.8	47	.....	ne.	.....
(Obs. del Est.)	5,186	24.90	83.7	40.1	58.1	51	.....	n.	.....
Guanajuato.....	6,640	23.66	79.2	30.7	57.0	49	.....	ws.w.	.....
Leon (Guanajuato)...	5,906	24.27	73.6	28.6	54.7	50	0.05	n.w.	.....
Mazatlan.....	25	29.89	79.5	55.9	70.0	71	.....	n.w.	w.
Merida.....	50	29.94	83.2	48.9	71.4	75	0.16	ne.	.....
Mexico (Obs. Cent.)...	7,472	23.01	71.2	30.9	52.5	51	.....	T.	.....
Monterrey (Sem.)...	1,636	28.20	97.7	31.1	57.9	54	.....	ne.	.....
Morelia (Seminario)...	6,401	23.91	73.0	30.2	54.9	60	.....	sw.	.....
Puebla (Col. Cat.)...	7,125	23.30	71.6	35.6	55.6	57	0.03	e.	.....
Puebla (Col. d. Est.)...	7,118	23.32	72.3	26.6	53.6	60	0.06	ene.	.....
Saltillo (Col. S. Juan)	5,399	24.76	72.7	29.9	51.4	55	.....	sw.	.....
Toluca.....	8,812	21.92	68.7	20.1	47.1	55	0.05	w.	.....
Tuxtla (Gutierrez, Chiapas)...	1,864	28.10	94.6	47.8	71.6	72	.....	n.w.	.....
Zapotlan.....	5,078	25.05	77.0	41.7	60.4	51	T.	n.	.....

\* Reduced to standard temperature and gravity.

### THE PHYSICAL BASIS OF LONG-RANGE WEATHER FORECASTS.<sup>1</sup>

By PROF. CLEVELAND ABBE.

The expression "long range" must not be misunderstood. It refers only to the length of time intervening between the date of making a weather prediction and the date when we expect it to be fulfilled. At the present time, by the help of the daily weather map, the official weather forecasters of this country, and indeed of every civilized nation on the globe, publish forecasts, in detail, of approaching weather changes, and especially storms, for one and two, or possibly occasionally three days in advance. These predictions all relate to comparatively minute details for regions that have been charted and studied daily for many years. They merely represent the direct teachings of experience; they are generalizations based upon observations but into which physical theories have as yet entered in only a superficial manner if at all. They are, therefore, quite elementary in character as compared with the predictions published by astronomers, based on the laws of gravitation and inertia, or the predictions sometimes offered by chemists, based on the laws that are being worked out by these investigators. Even the electrician, familiar with mathematical physics ventures on predictions based on far more complex theories than are as yet at the command of the meteorologists. But the latter are slowly building a grand structure, mathematical, graphical, and numerical, in which deductive reasoning will take the place of empirical rules. The whole will eventually form a complex intellectual machine, by means of which the general, and possibly the detailed phenomena of the atmosphere, will be followed up day by day. Then we shall be justified in calling our work rational science, as distinguished from empirical science. I use the word science in its fundamental meaning, as referring to that of which we have accurate knowledge, and not that which is purely speculative.

While I thus indulge hope in the prospective future high perfection of the science of the weather, I recognize the fact that we must not expect to realize these hopes in this generation. The progress of all science is necessarily slow. From Copernicus to Kepler, from Kepler to Newton, from Newton to La Place, and from La Place to the living giants in the theoretical astronomy of to-day, we proceed by steps of a century each. In chemistry, from Berzelius to the present day, we have scarcely one such step. In electrical science we are less than a century distant from Ohm and Green. In meteorology, considered as an application of physics, we begin with Espy's work of 1830, but considered as a branch of mathematical science we begin with Ferrel's work of 1856. The development of a correct "Theoria meteorologica" has made good progress during the past twenty years, but we are still at work on the introductory chapter. Some would hasten the work by unnatural stimulants in response to the feverish anxiety of the people and the daily newspapers, but we must be content to await the surer results of a slow but natural growth. Personally, I hope I may live to see the day when some of our universities will offer attractive courses in dynamic, experimental, and observational meteorology to advanced students of mathematics and physics, when those who are prepared to profit by such lectures may in their turn contribute to the advancement of our knowledge. It will not do for us to be so absorbed in so-called practical work as to neglect the research work that is still more practical. The practical work of to-day is but the application of the results of the past research. The research of to-day will be the basis

<sup>1</sup>This paper is a summary of lectures delivered at Johns Hopkins University in February, 1901. It was prepared for the meeting of the American Association for the Advancement of Science, Denver, August, 1901, and is now first published.